

# Overview of NextGen Institute Project

Optimizing Aircraft Sequencing  
and Spacing in the Terminal  
Area Airspace to Increase  
Airport Capacity, Reduce Fuel  
Burn and Emissions, and  
Reduce Noise on Developed  
Terminal Paths

Presented to: EWG Operations SC

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Federal Aviation  
Administration



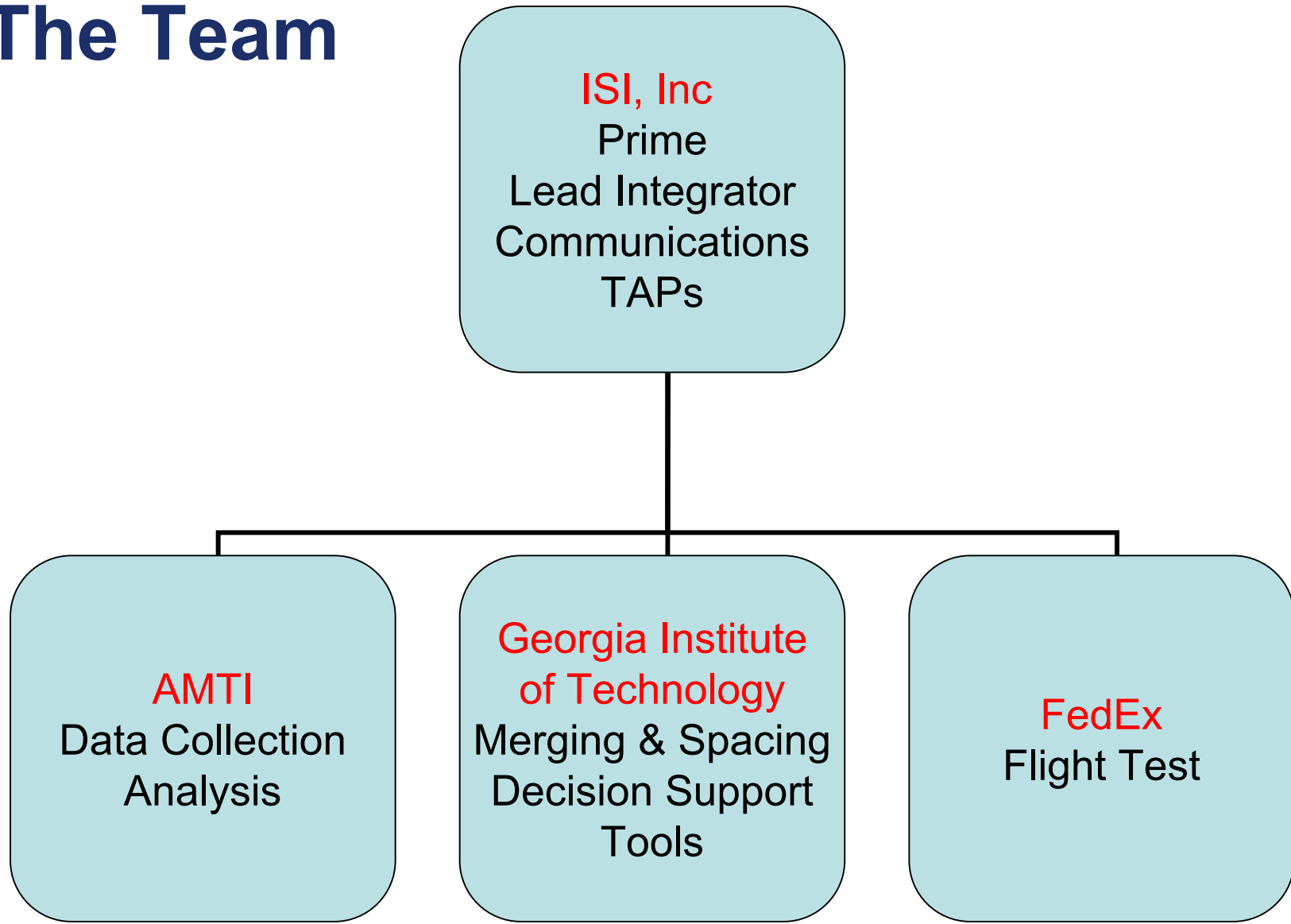
# Purpose

- Conduct investigations into the integration of Communication, Navigation and Surveillance (CNS)/ Air Traffic Management (ATM) technologies to support applications that reduce fuel burn, emissions and noise, and alleviate terminal area airspace congestion.
  - Increase airport throughput by demonstrating how currently-available technologies that exploit the advances in CNS systems, optimize aircraft flight trajectories, sequencing, and timing in the terminal area airspace.

# Objectives

- Decreased Fuel Burn and Emissions
- Reduction in Noise
- Increased Approach Availability
- Decreased Minima where possible
- Optimized Aircraft Sequencing in Real Time
- Stable Arrival/Approach Procedures to Terminal Area Operations
- Continuous Descent Throughout Arrival and Approach
- Minimized Flight Time in Terminal Area
- Minimized Impact to ATC

# The Team



# Tasks – Phase I

1. Coordinate with airline, industry, academia, and airport personnel to reach agreement with the project objectives and understand air traffic controllers' national and local constraints.
2. Develop different formulations and cognitive engineering models to support the terminal area airspace issues and operations, and develop report.
3. Develop mathematical and cognitive engineering models of the operations at an airport, that can be used in future JPDO work related to airport operations.
4. Provide a feasible concept for optimizing the sequencing and timing of aircraft in the terminal area airspace to increase airport throughput and reduce fuel burn emissions.
5. Determine appropriate currently available surveillance tool
6. Develop continuous descent approach TAP procedures



# Tasks – Phase II

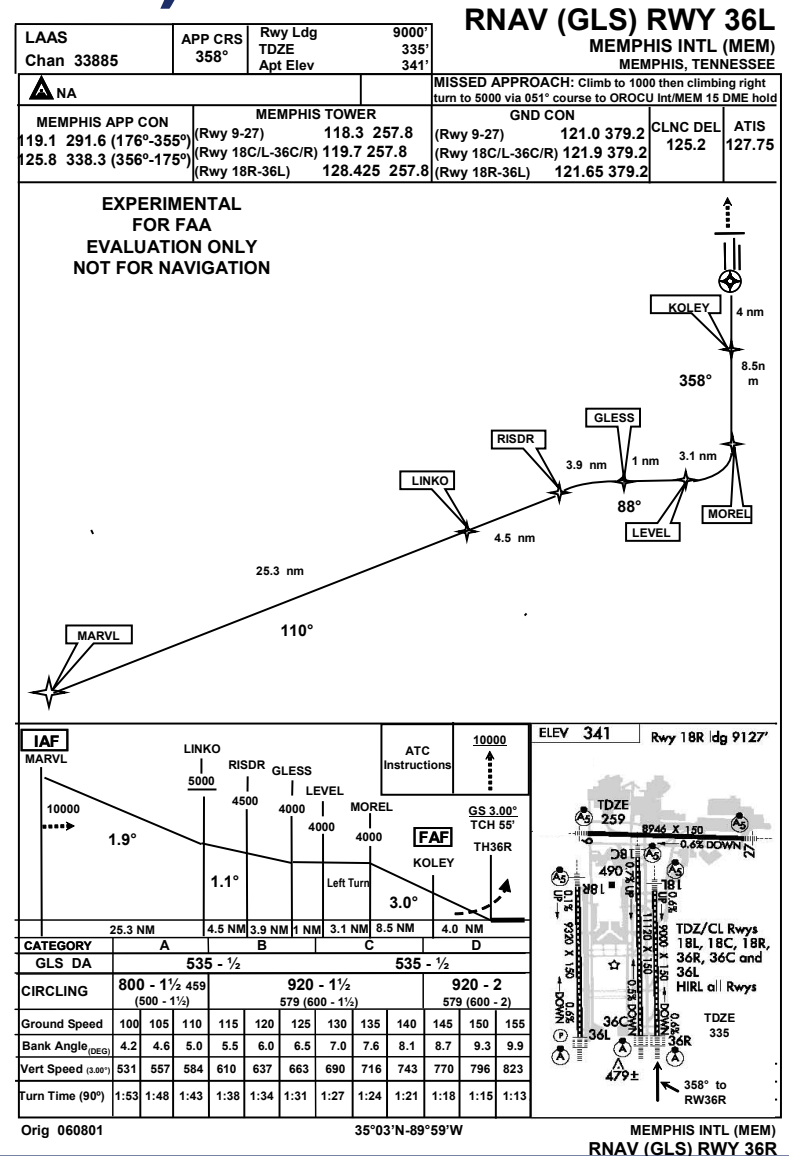
1. Model Environmental Benefits
2. Create a Flight Demonstration Plan
3. Perform Flight Demonstration
4. Conduct Environmental and Operational Improvements from flight demonstration data
5. Report on Flight Demonstration



# Terminal Area Path (TAP) Procedures

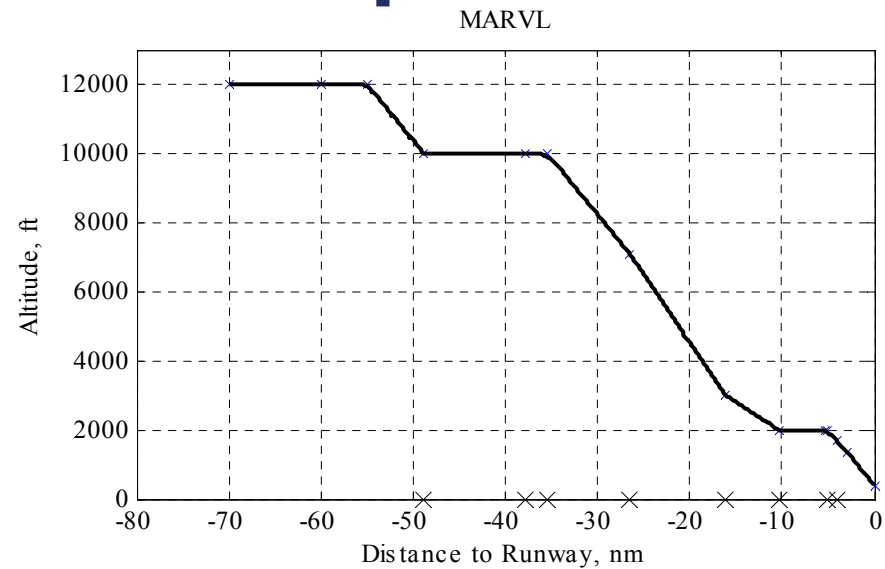
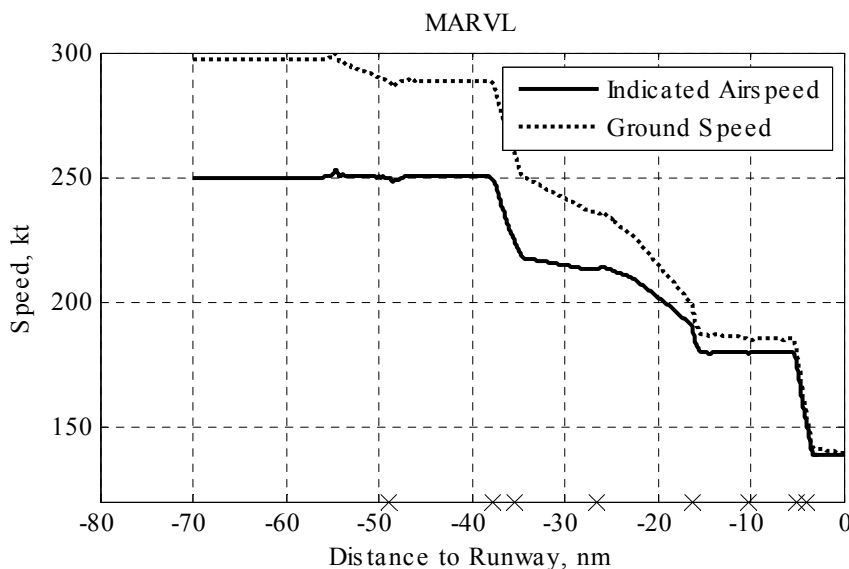
- TAP procedure will use GPS satellites and the prototype Ground Based Augmentation System (GBAS)
- Vertical profile TAP procedure in the TRACON airspace closely approximates a CDA low power approach

Experimental – For FAA Evaluation Only

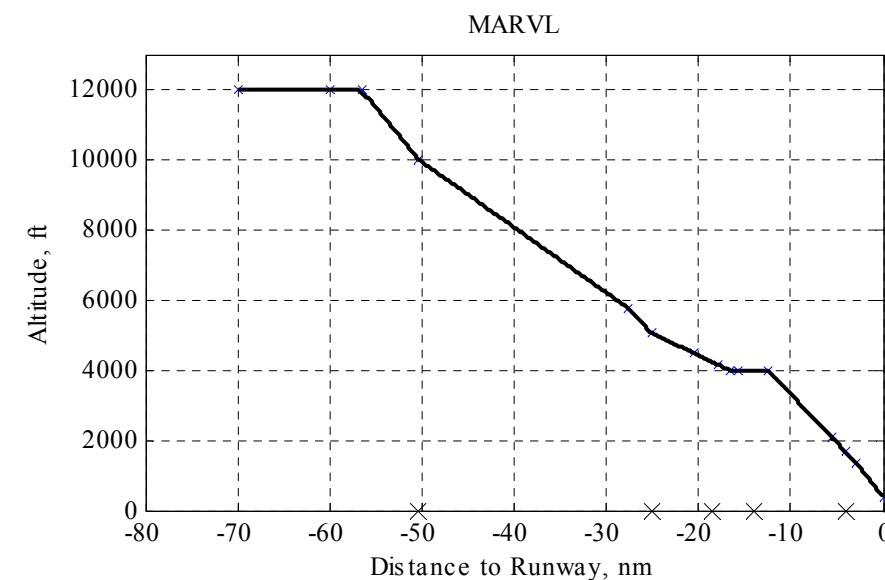
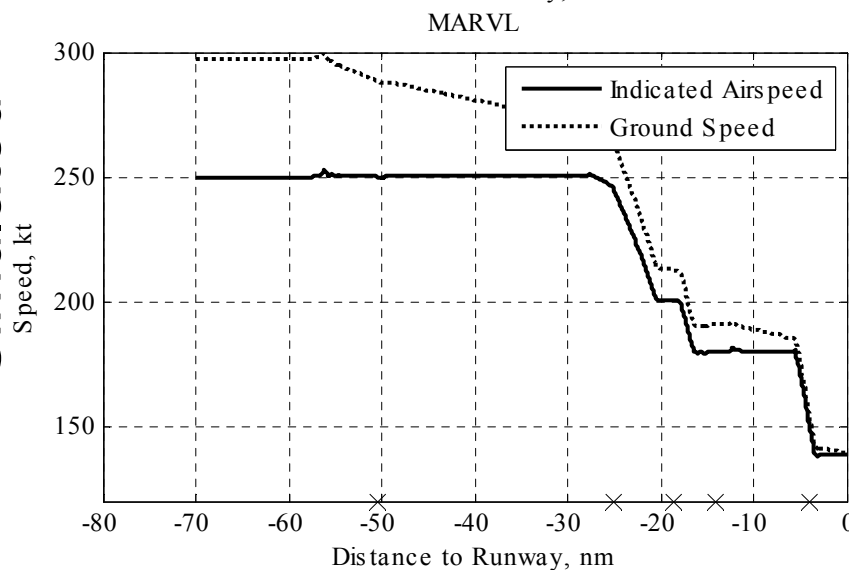


# Baseline and TAP Path Comparison

Baseline  
Simulated



TAP  
Simulated





# Operational Modeling

- **Two models developed by Georgia Institute of Technology will be used to model the sequencing and spacing needed to perform the TAP procedures**
  - Tool for Analysis of Separation and Throughput (TASAT)
    - A Monte Carlo simulation environment that has been developed to predict trajectory variations of aircraft conducting the approaches.
    - A separation analysis methodology that has also been developed to determine target sequencing and spacing required at the intermediate metering point.
  - En route Speed Change Optimization Relay Tool (ESCORT)
    - Solves a speed optimization and sequencing problem for en route (or terminal area) aircraft in real time
    - Minimizes the increase in fuel usage that may be necessary to achieve the necessary spacing to fly a TAP
    - Fairly divides the fuel usage increase among the aircraft involved

# Integrated System Capabilities

- **TASAT/ESCORT**
  - Decision support tool to calculate speed commands, required times of arrival (RTA), proper spacing, and sequencing
- **3-dimensional profiles from boundaries of ARTCC to corner post and TAP procedure from corner post to runway threshold**
- **Weather information**
  - Wind Conditions are important due to affects of wind on trajectories
  - Use both historic (for statistical probability of trajectory) and current information
  - Aircraft Communications Addressing and Reporting System (ACARS)
- **Surveillance System**
  - Must provide accurate and real time position data for RTA and speed calculation by TASAT/ESCORT, as well as monitoring progress to determine if new speed calculations are needed
  - ETMS will be used because not all aircraft have ACARS and ADS-B would require an installation of new equipment on the aircraft

# Integrated System Capabilities (cont)

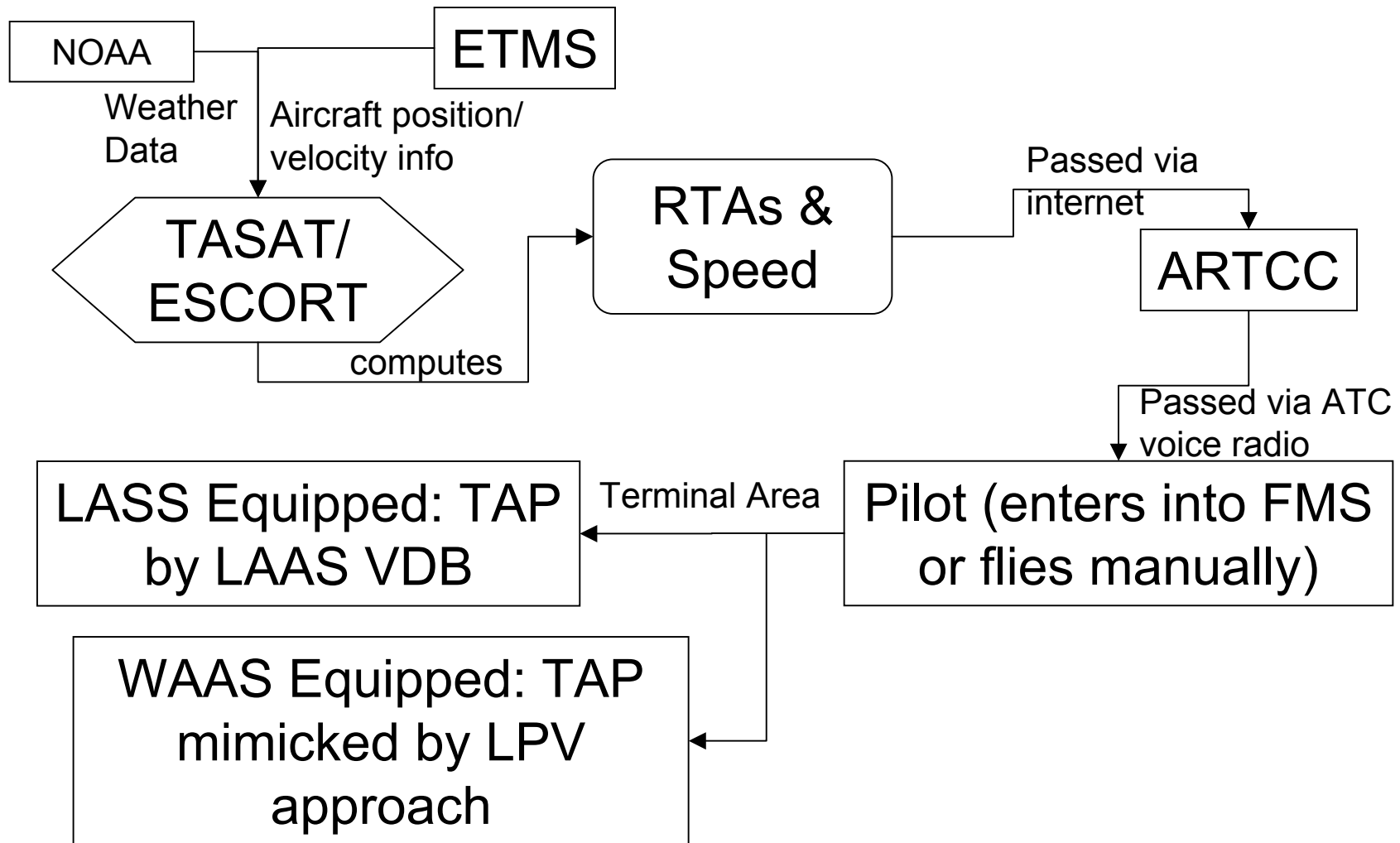
- **Navigation System**

- GPS based technologies Satellite Based Augmentation System (SBAS) and Ground Based Augmentation System (GBAS) will be used for the demonstration because it provides for more accurate vertical profiles for the TAP procedures
- Local Area Augmentation System (LAAS) or Wide Area Augmentation System (WAAS) will be used
  - For equipped aircraft, WAAS will be used (use an LPV approach procedure similar to the TAP procedure created)
  - LAAS has been installed at Memphis; provides the information through a VHF data link (VDB)
    - Some test aircraft will be fitted with test LAAS avionics from the FAA Technical Center

- **Communication System**

- Must be usable as a message communication system with several characteristics:
  - real time, two-way data transmission
  - user-to-user communication
  - interoperability among users and organizations.
- Provide both air to ground and ground to ground communications.
- ATC VHF voice radio for the air ground communications and the telephone or internet for the ground to ground communications requirements.
- LAAS VDB to broadcast the approved complex TAP procedures to be used by the flight test aircraft.

# Schematic



# Environmental Modeling of Benefits

- **Noise**

- Modeled using Integrated Noise Model (INM) version 7.0
  - User defined profiles created from TASAT
  - Metrics to be computed:
    - A-weighted SEL
    - A-weighted LMAX

- **Emissions/Fuel Burn**

- Modeled using the Boeing Fuel Flow Method
  - Emissions to be computed:
    - carbon monoxide (CO)
    - hydrocarbons (HC)
    - sulfur oxides (SOx)
    - carbon dioxide (CO<sub>2</sub>)
    - nitrogen oxides (NO<sub>x</sub>)
    - particulate matter (PM)

# Preliminary Environmental Results

## Comparison of Distance, Flight Time, and Fuel Burn between Baseline and TAP Procedures

Procedure	Parameters	Baseline	TAP	Change	Percent
GILMR	Distance	52.12	61.08	8.96	17%
	Flight Time	868	965	97	11%
	Fuel Burn	961	1040	79	8%
MIOLA	Distance	69.85	73.25	3.40	5%
	Flight Time	1153	1166	13	1%
	Fuel Burn	1545	1417	-128	-8%
MARVL	Distance	48.83	50.37	1.54	3%
	Flight Time	810	806	-4	0%
	Fuel Burn	892	893	1	0%
HOLLI	Distance	39.26	43.87	4.61	12%
	Flight Time	683	762	79	12%
	Fuel Burn	791	848	57	7%

Note: Boeing 737-300 aircraft, values are calculated from corner fix and runway threshold. Distance in nm, flight time in sec, fuel burn in lb.

# Preliminary Environmental Results (cont)

Procedure	Species	Baseline	TAP	Change	Percent
<b>GILMR</b>	<b>NOx, lb</b>	3.40769	2.48533	-0.92236	-27%
	<b>HC, lb</b>	0.0507770	0.0622084	0.0114314	23%
	<b>CO, lb</b>	1.526575	1.568171	0.041596	3%
	<b>CO2, lb</b>	1180.97	895.39	-285.58	-24%
	<b>SO2, lb</b>	0.299454	0.227041	-0.072413	-24%
<b>MIOLA</b>	<b>NOx, lb</b>	4.95565	7.03194	2.07629	42%
	<b>HC, lb</b>	0.0860627	0.0754815	-0.0105812	-13%
	<b>CO, lb</b>	2.164565	2.008226	-0.156339	-7%
	<b>CO2, lb</b>	1632.97	2149.60	516.63	32%
	<b>SO2, lb</b>	0.414066	0.545065	0.130999	32%
<b>MARVL</b>	<b>NOx, lb</b>	5.94482	2.49448	-3.45034	-58%
	<b>HC, lb</b>	0.0837592	0.0619150	-0.0218442	-26%
	<b>CO, lb</b>	2.248335	1.565996	-0.682339	-30%
	<b>CO2, lb</b>	1909.92	898.37	-1011.55	-53%
	<b>SO2, lb</b>	0.484291	0.227796	-0.256495	-53%
<b>HOLLI</b>	<b>NOx, lb</b>	8.91353	7.03021	-1.88332	-21%
	<b>HC, lb</b>	0.1398804	0.0993735	-0.0405069	-29%
	<b>CO, lb</b>	3.192206	2.411085	-0.781121	-24%
	<b>CO2, lb</b>	2679.33	2178.22	-501.11	-19%
	<b>SO2, lb</b>	0.679386	0.552321	-0.127065	-19%

Note: Boeing 737-300 aircraft, values reflect below 3,000 ft AFE and prior to landing



# Flight Demonstration Modeling Aircraft

- Aircraft Operators donating all costs associated with operating the flight demo, including pilot cost and landing fees
- Aircraft Identified to be used:
  - B727
  - Lear 60
  - CRJ-200
  - Lear 35
  - Global Express



# Flight Demonstration Coordination

- Memphis Local Area Augmentation System (LAAS) is ready to broadcast the Terminal Area Path (TAP) procedures,
- The Multimode Receivers (MMR) must be modified to be able to: receive the TAP procedures; interface/integrate with the Flight Management System (FMS) and the Flight Data Recorder (FDR).
  - For those aircraft without a MMR, GPS Wide Area Augmentation System (WAAS) receivers will be used.
- Installation and testing of the modified test MMR and to put the aircraft into a test mode. Each flight test aircraft must also have a verified and tested truthing system, operating properly.
- Coordinate with ATC controller union members to participate in this flight test and/or availability and use of ATC managers during the flight tests.
- Verify airspace availability during the flight tests for holding patterns and flight paths for the flight test aircraft to fly out and back on their designated TAP and en route procedures.
- ARTCC and TRACON have simulated and approved the TAP and en route procedures for the flight tests



# Tentative Phase II Schedule

- Model Environmental Benefits – January 5, 2009
- Create a draft Flight Demonstration Plan – January 30, 2009
- Create a Flight Demonstration Plan – March 2, 2009
- Perform Flight Demonstration – March 2009 (two weekends)
- Conduct Environmental and Operational Improvements from flight demonstration data – June 30, 2009
- Report on Flight Demonstration – August 31, 2009